

**COLORADO RIVER RECOVERY PROGRAM
FY-2006-2007 PROPOSED SCOPE-OF-WORK:**

No: 22-f

Lead Agency: Larval Fish Laboratory

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Category:

- ☐ Ongoing project
☒ Ongoing-revised project
☐ Requested new start
☐ Unsolicited

Expected Funding Source:

- ☒ Annual funds
☐ Capital funds
☐ Other (explain)

Date: 28 April 2005

Revised date:

I. Title of Proposal: **INTERAGENCY STANDARDIZED MONITORING PROGRAM (ISMP) ASSESSMENT OF ENDANGERED FISH REPRODUCTION IN RELATION TO FLAMING GORGE OPERATIONS IN THE MIDDLE GREEN AND LOWER YAMPA RIVERS.**

II. Relationship to RIPRAP:
Green River Action Plan: Mainstem

- I. Provide and protect instream flows--habitat management.
.A. Green River above Duchesne River.
.1. Initially identify year-round flows needed for recovery while providing experimental flows.
I.A.2.a. Summer/fall flow recommendations.
I.A.3. Deliver identified flows.
I.A.3.a. Operate Flaming Gorge pursuant to the Biological Opinion to provide summer and fall flows.
I.A.3.d. Operate Flaming Gorge Dam to provide winter and spring flows and revised summer/fall flows, if necessary.
I.B. Green River below the Duchesne River.

- I.B.1. Initially identify year-round flows needed for recovery while providing experimental flows.
- I.B.2. State acceptance of initial flow recommendations.
- I.B.2.a. Review scientific basis.
- II. Restore habitat--habitat development and maintenance.
 - II.A. Restore and manage flooded bottomland habitat.
 - II.A.1. Conduct site restoration.
 - II.A.1.a. Old Charlie Wash.
 - II.A.1.a.(3) Monitor and evaluate success.
 - II.C. Enhance water temperatures to benefit endangered fishes.
 - II.C.1. Identify options to release warmer water from Flaming Gorge Reservoir to restore native fish habitat in the Green River.
- V. Monitor populations and habitat and conduct research to support recovery actions--research, monitoring, and data management.
 - V.A. Conduct research to acquire life history information and enhance scientific techniques required to complete recovery actions.

Green River Action Plan: Yampa and Little Snake Rivers

- I. Provide and protect instream flows--habitat management.
 - I.D. Yampa River below Little Snake River.
 - I.D.1. Initially identify year-round flows needed for recovery.
 - I.D.2. Evaluate need for instream flow water rights.
 - I.D.2.a. Review scientific basis.

Green River Action Plan: Yampa and Little Snake Rivers

- V.A.1. Conduct standardized monitoring.
- V.B.2. Conduct appropriate studies to provide needed life history information.

III. Study Background/Rationale, and Hypotheses:

The goal of the recently approved Flaming Gorge flow and temperature recommendations (Muth et al., 2000) was to improve the status and prospects for recovery of endangered fish populations in the Green River. A major emphasis of those recommendations was to enhance the reproductive and recruitment success of endangered fishes in the middle Green River, in particular razorback sucker and Colorado pikeminnow. The primary means to achieve enhanced populations will be to pattern flows after a more natural hydrograph, the timing and duration of which will be based on anticipated annual hydrologic conditions and the biology of the fish. Because of vagaries in timing and runoff patterns within and among various hydrologic scenarios, and uncertainties in anticipated effects of flow and temperature recommendations on endangered fishes, Muth et al. (2000) suggested that real-time data be gathered to guide and fine tune operation of Flaming Gorge dam each year. This proposal extends past sampling conducted to monitor timing of reproduction and abundance of early life stages of endangered razorback sucker *Xyrauchen texanus* and Colorado pikeminnow *Ptychocheilus lucius*.

Razorback sucker sampling in spring.--A key objective of spring flows is to provide flood plain habitat for early life stages of razorback suckers in the Jensen-Ouray reach of the Green River. Flood plain inundation should provide relatively warm and food-rich habitat for early life stages of fish that may enhance recruitment success of razorback suckers. Green River flows released from Flaming Gorge Dam will be timed to coincide with high spring flows from the Yampa River to ensure maximal habitat availability.

However, success of flood plain inundation to enhance recruitment of razorback suckers depends on matching the timing of appearance of larvae in the river with availability of flood plain habitat. Sampling of razorback sucker larvae during spring and early summer will ensure that flows are released at the correct time and for a sufficient duration to promote recruitment. Presence of catostomid larvae in samples collected from the Green River facilitated decisions regarding timing, level, and duration of flows to inundate flood plain habitat in spring and early summer 1999.

Additional information from light trap sampling of razorback suckers includes a measure of reproductive success of stocked razorback suckers that are now of sufficient size and age to reproduce. Wild adult razorback suckers in the Green River Basin were very rare by year 2000 and the few remaining fish present at that time may have succumbed (Bestgen et al. 2002). Thus, all reproduction observed is likely by adults that were stocked. The level of reproduction is an important metric to determine reproductive success of stocked fish in the Green River. The timing of presence of larvae in the system also permits evaluation of whether timing of flow releases from Flaming Gorge Dam coincide with the peak number of razorback sucker larvae in the Green River.

Another use of light trap sampling information is to further evaluate results of experimental releases of marked larvae and subsequent entrainment into floodplain wetlands. That work is planned for at least the next two years, depending upon availability of flows. Batches of marked larvae will be released at the spawning bar during different levels of flow. Batch marks associated with releases will allow identification of which release and flow level a captured marked larvae came from. That information will be useful to evaluate what flow level and time is most effective to entrain released marked larvae into the floodplain wetlands.

Colorado pikeminnow sampling in summer.--An objective of Flaming Gorge Dam base flow recommendations in summer is to provide backwater habitat in the middle and lower Green River for early life stages of Colorado pikeminnow. The time of year that base flows are achieved in summer and the flow level will be generally dependent upon the annual hydrologic condition. However, onset of reproduction of Colorado pikeminnow in the Yampa River is variable from year to year as is the timing of peak production of larvae (Bestgen et al. 1998). More precise information on timing and extent of reproduction of Colorado pikeminnow could be used to fine tune when the summer base flow period begins and the level of summer base flows from Flaming Gorge Dam. Timing of reproduction of Colorado pikeminnow and abundance of larvae has been used since 1990 to justify decisions regarding onset of summer baseflows from Flaming Gorge Reservoir. In addition, presence and abundance of pikeminnow larvae in the Yampa River was used to make decisions regarding timing, duration, and magnitude of 1998 summer flows released from Flaming Gorge Reservoir when inflows dramatically exceeded expectations.

Presence of Colorado pikeminnow in the Yampa River is also a means to evaluate if Flaming Gorge flow releases in summer comply with the criteria that Green River temperatures be no more than about 5C different than the Yampa River. Compliance with the recommendation ensures that the potential of cold shock of Colorado pikeminnow larvae drifting from the warm Yampa River into the cooler Green River is minimized.

Additional information provided by drift-net sampling of Colorado pikeminnow larvae is an index of annual reproduction by the adult population that congregates in the lower Yampa River each year. This area represents one of two main spawning areas for

Colorado pikeminnow and sampling of early life stages may provide an index of adult abundance and spawning success. We are also using an index of annual reproductive success to relate to annual recruitment success of young-of-year Colorado pikeminnow in downstream backwaters of the Green River in the Jensen-Ouray reach. Collectively, that information will be useful to investigate hypotheses regarding the apparent decline of recruitment of young Colorado pikeminnow in backwaters of the Green River, and the effects it may be having on the adult population there.

Temperature monitoring.--Muth et al. (2000) also included two specific temperature recommendations for Flaming Gorge Dam releases. The first was that the Green River reach a temperature of at least 18°C in upper Lodore Canyon in summer under average and drier hydrologic scenarios. Warmer water would benefit growth and condition of resident native fishes in Lodore Canyon and may provide conditions needed for reproduction by the resident population of Colorado pikeminnow. The second recommendation was that the summer temperature of the Green River be no more than about 5°C cooler than the Yampa River. This recommendation was made to reduce the chance of temperature shock to Colorado pikeminnow larvae drifting from the Yampa River into the colder Green River. Monitoring of summer water temperatures in the Green and Yampa rivers is needed to ensure that recommendations are being met and will guide changes in operation of Flaming Gorge Dam if they are not. Meeting temperature recommendations will be especially important when drifting Colorado pikeminnow larvae are present in the system.

Other recommendations for research to consider for out years.

1). Additional razorback sucker sampling.--The presence of razorback sucker larvae at several key locations will provide the bulk of the information used to regulate timing and level of flows from Flaming Gorge Dam in spring. Such areas presently include Cliff Creek, Stewart Lake/drain, Greasewood Corral, and Sportsman's drain. Although these areas support the most consistent capture locations for larvae, even these vary substantially from year to year depending on flow and other conditions. Additional sampling areas that are known to support early life stages of razorback suckers within the middle Green River would give managers better estimates of the timing and duration of the spawning season. Drift-net sampling in spring 2004 associated with a release of marked hatchery-produced razorback sucker larvae and beads also revealed substantial downstream transport of wild razorback sucker larvae. Driftnet sampling may still be a useful tool to monitor reproduction by razorback suckers.

2). Flow regulation of annual recruitment of Colorado pikeminnow.--A key difference between flow recommendations made in the 1992 opinion and new recommendations is that summer base flow level will be dictated by the prevailing hydrologic condition rather than being fixed at a single level of 51 m³/sec. Thus, in wetter years base flows will be higher and in drier years base flows will be lower. The expected biological response by Colorado pikeminnow to this action is unknown. Thus, it is important to evaluate the response of these fish to new summer base flow conditions. One possible response is altered recruitment levels, which may be detectable from autumn ISMP sampling designed to estimate young-of-year (yoy) pikeminnow abundance in backwaters. Because this measure of fish abundance, which is presumably correlated with habitat suitability, could be confounded with variable levels of reproduction, drift sampling that continues throughout the summer reproductive season is needed to correctly interpret those data. For example, near absence of age-0 Colorado pikeminnow in the middle Green River in 1994 would have been difficult to interpret given that habitat conditions,

including relatively low flow levels and warm water temperatures, seemed suitable for recruitment. Drift data from the Yampa River at Echo Park demonstrated that recruitment failure in the middle Green River in summer 1994 was likely due to very low levels of drift of larvae measured in the Yampa River downstream of the spawning area.

The complexity of recruitment processes for Colorado pikeminnow needs to be more clearly defined so that effects of re-regulation of Flaming Gorge Dam can be ascertained. Minimally this would involve more certain estimates of yoy recruitment, perhaps through abundance estimation. Better resolution of the link between recruitment of age-0 pikeminnow and older age-classes may also better define what other conditions are needed for successful recruitment to older life stages. For example, an analysis of existing ISMP data for Colorado pikeminnow (Muth et al. 2000) suggested that successful recruitment to age-1 may be associated with successive low water years. Such information would be useful to link flow recommendations across years, and presumably, benefit pikeminnow recruitment.

3). Inter-annual recruitment patterns of Colorado pikeminnow.--Another means that altered patterns of recruitment could be manifest is through changes in within season recruitment patterns. For example, if flow induced backwater conditions are not suitable for survival of Colorado pikeminnow larvae early in the season, one should expect few such larvae to recruit to fall. Alternatively, poor conditions in backwaters later in the season may similarly limit recruitment of late-hatching larvae. A means to examine such recruitment patterns would be through comparative analysis of distributions of hatching dates derived from otoliths of larvae and juveniles captured later in fall. An expectation of such an analysis would be that distributions of hatching dates for each life stage would be similar, with large cohorts of larvae responsible for relatively large portions of the juveniles produced. Absence of juveniles hatched during times when relatively large numbers of larvae were produced may signal recruitment loss during those periods. Examination of the environmental conditions (flow level, water temperatures) present during such periods would assist in determining reasons for recruitment variation and whether such conditions were attributable to operation of Flaming Gorge Dam.

IV. Study Goals, Objectives, and End Product:

Goal

The goal of this project is to detect timing of reproduction by razorback sucker and Colorado pikeminnow, and determine patterns of presence of larvae and their relative abundance downstream of potential spawning sites in the middle Green River system. A second goal is to monitor temperature regimes of the Green and Yampa rivers in order to comply with Flaming Gorge flow recommendations. This will be accomplished by George Smith, U. S. Fish and Wildlife Service.

Objectives

- 1). To determine timing and duration of spawning by razorback suckers and presence and abundance of larvae in the system as measured by capture of larvae in light traps.

- 2). To determine timing and duration of spawning by Colorado pikeminnow and presence and abundance of larvae in the system as measured by capture of larvae downstream of spawning areas in the lower Yampa River.

End Product

A summary data report will be submitted at the end of each fiscal year to the monitoring program coordinator and the database coordinator. Data will also be provided as needed to provide for real-time management of flows from Flaming Gorge Dam.

V. Study Area:

Razorback sucker.--The study area for razorback sucker sampling is the middle Green River from the Escalante reach spawning area to near Sand Wash. Several specific sampling sites are located within the reach which were chosen because of documented presence of larval razorback sucker in the past. Most of these sites are associated with off-channel habitats such as tributary streams, washes, backwaters, or flooded bottomlands and are in the vicinity of the Escalante spawning bar (RM 301.7 - 319.4), Jensen (RM 276.9 - 301.7), and Ouray (RM 248.1 - 276.9). Additional sampling may be conducted in other locations within the middle Green River if suitable habitat is found and if the budget allows. Sites may also be chosen to attempt sampling of released marked larvae in the spring of 2005 and into the future. Field crews have flexibility to change sites or sample additional sites based on discharge, accessibility, and habitat conditions at each site.

Colorado pikeminnow sampling.--A single site, the lower Yampa River, will be sampled in FY-2006-2007. This locality was sampled as part of the Flaming Gorge studies program because it is downstream of a known spawning area for Colorado pikeminnow. Data obtained from samples will provide information on timing and relative abundance of Colorado pikeminnow larvae being transported from spawning areas and into potential nursery habitats and will also provide real-time data with which to manage flows from Flaming Gorge Dam.

VI. Study Methods/Approach:

Razorback sucker.--Approaches for sampling razorback sucker larvae in the Green River system were outlined in recommendations by Muth (1995), which were based on comprehensive literature and data reviews. Sites with documented high captures of larval razorback sucker will be targeted for sampling. Light-trap sampling at night in low-velocity nursery habitats will be the primary technique for monitoring. Light traps will be a floating, quatrefoil design commercially available from Southern Concepts in Birmingham, Alabama. Additionally, fine-mesh seines (1.6-mm or 3.2-mm mesh) will be used on a limited basis during daylight (also possibly at night) to document relative abundance of sympatric species not captured by light traps. Sampling will be conducted at each site twice weekly during at least early/mid May--mid June. The sampling period will be adjusted based on timing and duration of spring flows, onset of main channel water temperatures of 14°C, and temporal occurrence of larvae. Each habitat on each sampling occasion will be sampled with at least three light traps and possibly three seine hauls (number of collections will depend on size and complexity of habitats). If possible, light traps will be set in or near emergent vegetation at dusk and retrieved before sunrise. Larger fish identifiable in the field will be counted and measured on site and released.

alive. Other fish will be euthanized with an overdose of tricaine methanesulfonate (MS-222), preserved in 100% ethanol, and returned to the Larval Fish Laboratory for processing. Unit of effort will be hours each light trap is set during darkness and area sampled by each seine haul. These approaches and considerations were revised based on comments from the Biology Committee and other researchers, and discussions with Monitoring Program Coordinators and ISMP workgroups. Monitoring will be coordinated with (or supported by) ISMP, evaluations of levee-removal strategies (Lentsch et al. 1995), investigations at Old Charlie Wash (Lead, Tim Modde), and evaluations of experimental stockings. The Larval Fish Laboratory (LFL) will be responsible for larval fish identification and processing, coordinating monitoring activities, integrating results/reports of sampling efforts, and preparing overall annual reports.

Colorado pikeminnow.--Passive drift-net sampling is an effective and proven method for capturing Colorado pikeminnow larvae. Sampling can provide a reasonable estimate of annual reproductive output from spawning areas. Colorado pikeminnow in the Colorado River Basin spawn on the descending limb of the hydrograph when water temperature is increasing (Nesler et al. 1988; Tyus and Karp 1989, Bestgen et al 1998, Anderson 1999, Trammel and Chart 1999). Sampling for Colorado pikeminnow larvae will be initiated based on those data and stream-flow conditions prior to sampling (probable start date in most years is mid-late June). Duration of the sampling period will depend on number of larvae collected in late-season samples, past data, and stream-flow conditions (probable end date is early-mid August).

Colorado pikeminnow larvae are most consistently captured in drift-net samples at dawn, and nearshore and midstream nets capture roughly equivalent numbers of fish/unit volume of water sampled (Haynes et al. 1984; Nesler 1986, Bestgen 1997, unpublished data). Therefore, at each station three plankton nets will be set near the shore, daily at dawn for 1-2 h, from end of June through early August. Some diel sampling should also be conducted at each site. This should include samples collected at dawn, noon, dusk and midnight and should be collected on 5-6 d spread throughout the sampling season. Nets will be attached to rectangular steel frames (0.15 m²) and staked into the stream substrate adjacent to the shore in water 0.5-1.0 m deep. A removable collection bucket for trapping filtered material and fishes will be attached to the cod end of each net. Flow meters for measuring velocity will be suspended inside the mouth of each net, and net sets will be timed to determine volume of water sampled. Duration of each set will be 1-2 h depending on debris load. Samples will be fixed and preserved in 95-100% ethanol (for subsequent otolith-ageing work if needed). Fishes will be picked from debris in the field, returned to the LFL, identified, measured to the nearest 0.1 mm total length, and enumerated.

VII. Task Description/Schedule (FY 2006 and 2007)

- I). Collect light trap samples for razorback suckers. The CRFP office in Vernal will be responsible for this task.
- II). Collect drift net samples for Colorado pikeminnow. The Larval Fish Laboratory will be responsible for this task.
- III). Preliminary identification of light trap and drift net samples. Preliminary identifications will be conducted by the responsible sampling entity, with assistance from the LFL, as samples are collected to provide real-time data. Final specimen identification and curation will be conducted by the LFL under Project 15.

IV). Summarize specimen data collection in an annual report.

VIII. FY-2006-2007 Work: Summarize data and incorporate into report.

-Description of Work: Tasks I-IV.

See above

-Deliverables

A key feature of this data is to be able to provide it to managers who need to make decisions about stream flows in real-time. The best means to provide such data would need to be resolved prior to sampling and would necessarily include biologists and water managers. A report will also be submitted by end of the fiscal year that summarizes data collected to date.

FY-2007 Budget

Larval Fish Laboratory, 2007 Budget. Salaries include 20.8 % fringe rate. Overhead is calculated on all items (including salary plus fringe rate) at 15%, except for equipment > \$5,000.

Larval Fish Laboratory, FY2007

Task 2, Collect drift net samples

Item	Units	Cost/unit	Cost
Labor			
Principal investigator (d)	18	425	\$7,650
Senior technician (d)	22	176	3872
Technician (d)	132	140	18480
			subtotal \$30,002.00
Travel			
Per diem (d)	122	20	\$2,440
Mileage (miles)	6800	0.37	\$2,516
			subtotal \$4,956.00
Supplies			
Preservative (gals)	55	12	\$660
Jars/vials	525	0.25	\$131
Tents	2	225	\$450
Drift net	1	350	\$350
Meter	1	220	220
misc camp gear	1	175	175
misc sampling gear	1	200	200
			subtotal \$2186.00
			Total \$37,144.00

Task 3, Identify light trap and drift net samples

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	25	425	\$10,625
Senior technician (d)	48	176	\$8,448
Technician (d)	35	140	\$4,900
		subtotal	\$23,973
Supplies			
Preservative (gals)	10	9	\$90
Jars/vials	200	0.25	\$50
microscope repair	2	225	\$450
misc lab gear	1	157	157
		subtotal	\$747
		Total	\$24,720

Task 4, annual; report preparation

Item			Cost
Labor	Units	Cost/unit	
Principal investigator (d)	11	425	\$4,675
Senior technician (d)	19	176	\$3,344
Technician (d)	5.2	140	\$728
		subtotal	\$8,747
Travel			
Annual mtgs	1	416	\$416
		subtotal	\$416
		Total	\$9,163

total tasks 2-4 \$71,027.00

USFWS, Vernal 2007 budget, task 1

SOW 22f FY2007

Task Activity	Cost
Labor	
GS 14 Project Leader (\$59.82/hr x 8 hr/day x 5 days/week x 1 week)	\$2,393
GS-13 Biologist (\$62.06/hr x 8 hr/day x 5 days/week x 8 weeks)	\$19,859
GS-5 Biologist (\$23.60/hr x 8 hrs/day x 5 days/week x 8 weeks)	\$7,552
Subtotal	\$29,804.00
Travel - round trip to sample site	
(100 mi x 3 times/week x 8 weeks x \$0.405/mi)	\$972
Vehicle maintenance (oil change, etc.)	\$30
Subtotal	\$1,002
Sample Supplies (light traps, boat motor repair, etc.)	\$3,367
Total	\$34,173.00

FY-2007 Budget \$105,200

Supply costs are for light traps and boat motor repair.

IX. Budget Summary	
FY-2006	\$126,646
FY-2007	<u>\$105,200</u>
Total:	\$ 231,846

X. Reviewers

XI. References

- Anderson, R. A. 1999. Evaluation of Gunnison River flow manipulation upon larval production of Colorado pikeminnow in the Colorado River, Colorado. Draft final report.
- Bestgen, K. R. 1997. Interacting effects of physical and biological factors on recruitment of age-0 Colorado squawfish. Unpublished Ph.D. Dissertation, Colorado State University, Fort Collins, Colorado. 203 pp.
- Bestgen, K. R., R. T. Muth, and M. A. Trammell. 1998. Downstream transport of Colorado squawfish larvae in the Green River drainage: temporal and spatial variation in

abundance and relationships with juvenile recruitment. Unpublished report to the Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. Contribution No. 97 of the Larval fish Laboratory. 98 pp.

- Bestgen, K. R., G. B. Haines, R. Brunson, T. Chart, M. Trammell, G. Birchell, and K. Christopherson. 2002. Decline of the razorback sucker in the Green River Basin, Utah and Colorado. Report submitted to the Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. Larval Fish Laboratory Contribution 126
- Haynes, C. M., T. A. Lytle, E. J. Wick, and R. T. Muth. 1984. Larval Colorado squawfish (Ptychocheilus lucius) in the upper Colorado River basin, Colorado, 1979-1981. *Southwestern Naturalist* 19:403-412.
- Lentsch, L., T. Crowl, and T. Modde. 1995. Evaluating the response of the Upper Colorado River basin aquatic system after levee removal (and consequent reconnection of floodplain wetlands to main channel flows), particularly the response of the endangered fish, razorback sucker and Colorado squawfish.
- Muth, R.T., and others. 2000. Flow and temperature recommendations for endangered fishes in the Green River downstream of Flaming Gorge Dam. Draft final report to the Upper Colorado River Recovery Program, Denver, CO.
- Nesler, T. P. 1986. Aquatic non-game research-1985-86. Squawfish-humpback studies. Colorado Division of Wildlife, annual job progress report SE-3, Fort Collins.
- Nesler, T. P., R. T. Muth, and A. F. Wasowicz. 1988. Evidence for baseline flow spikes as spawning cues for Colorado squawfish in the Yampa River, Colorado. *American Fisheries Society Symposium* 5:68-79.
- Trammell, M., and T. Chart. 1999. Evaluation of Gunnison River flow manipulation upon larval production of Colorado pikeminnow in the Colorado River, Utah. Draft final report.
- Tyus, H. M., and C. A. Karp. 1989. Habitat use and streamflow needs of rare and endangered fishes, Yampa River, Colorado. U.S. Fish and Wildlife Service, Biological Reports 89(14):1-27.